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Engelmann Spruce

An American Wood

Engelmann spruce, one of the lightest of all the important commercial woods in the United States, is soft, machines well, and has low shrinkage and uniform color. The wood closely resembles that of the eastern spruces in appearance and properties and, like them, has excellent pulping properties. It is used principally in home construction for framing, sheathing, interior paneling, and exterior trim; for plywood manufacture, food containers, and specialty items; and for pulp and paper.

F-320890

Engelmann Spruce

(*Picea engelmannii* Parry ex. Engelm.)

Donald C. Markstrom and Robert R. Alexander[1]

Distribution

Engelmann spruce, a major component of the high-elevation Rocky Mountain forests, is widely distributed in the western United States and two Provinces in Canada. It grows in the Rocky Mountains of southwestern Alberta south through the high mountains of eastern Washington and Oregon, Idaho, western Montana, to western and central Wyoming, and in the high mountains of southern Wyoming, Colorado, Utah, eastern Nevada, New Mexico, and northern Arizona (fig. 1).

In the Pacific Northwest, Engelmann spruce grows along the east slope of the Coast Range from west-central British Columbia, south along the crest and east slope of the Cascade Range through Washington and Oregon to northern California. It is a minor component of these high-elevation forests.

Engelmann spruce is found most typically in association with subalpine fir (*Abies lasiocarpa*) and with it forms the Engelmann spruce–subalpine fir forest type. It also grows in mixture with other species, and stands of mixed composition where spruce predominates are common throughout the Rocky Mountains. These stands occur from the headwaters of mountain streams near timberline, to protected north and east slopes at lower elevations where moisture and temperature are not limiting. Spruce grows in many kinds of stands, varying from a few scattered trees near timberline to unbroken, dense forests below. Although Engelmann spruce sometimes grows in pure stands, pure stands are uncommon.

Engelmann spruce grows at many elevations throughout its range, depending on local climatic and physiographic conditions. Engelmann spruce trees of merchantable size and form are found at intermediate and lower elevations,

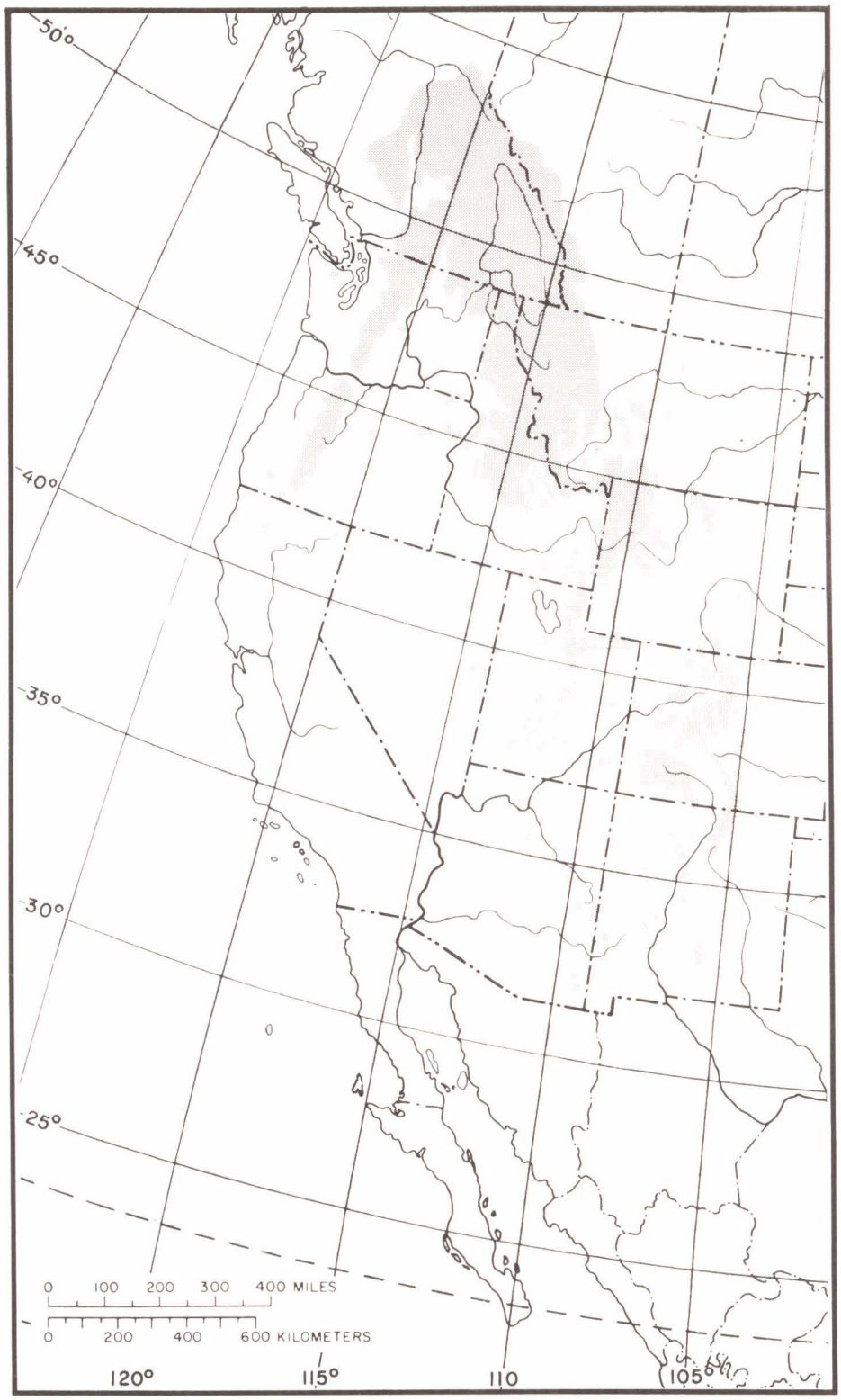

Figure 1—Natural range for Engelmann spruce, *Picea engelmannii* Parry. F-532730

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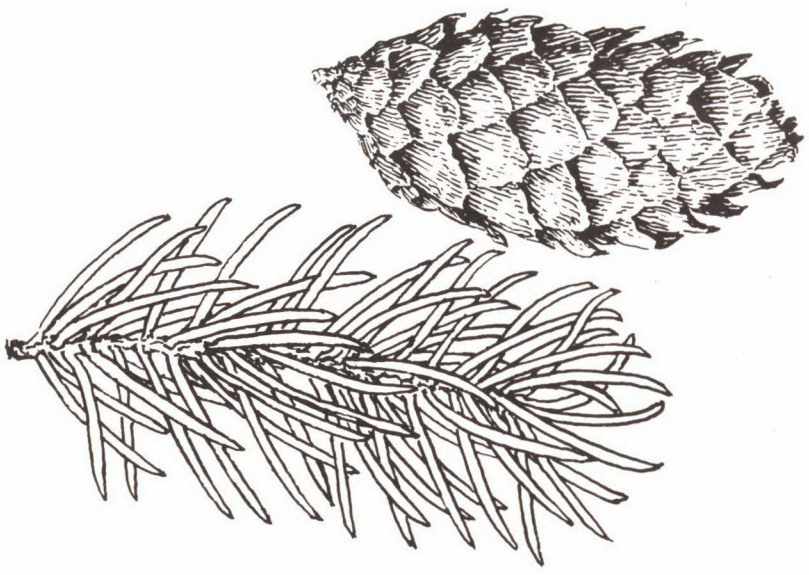

Figure 2—Needles and cone of Engelmann spruce. F-462254

but at timberline they are commonly stunted. The amount of merchantable sawtimber that can be cut from typical natural stands containing Engelmann spruce varies from practically nothing at timberline to as much as 80,000 board feet per acre on the best sites.

Description and Growth

Engelmann spruce is one of the largest of the high-elevation species. Under favorable conditions, a stand will vary from 15 to 30 inches in average diameter at breast height, and from 45 to 130 feet in average height. Individual trees may exceed 40 inches in diameter and 160 feet in height. Engelmann spruce is a long-lived tree, maturing in about 300 years. Trees living 500 to 600 years are not uncommon.

The root system of Engelmann spruce is shallow but well developed. Mature trees have a number of large lateral roots generally less than 2 feet below the ground surface. These roots may extend 20 or more feet from the trunk. This extension enables the tree to survive on shallow soils but makes it dependent upon superficial soil moisture, susceptible to windthrow, and subject to root injury from surface fire. The thin bark is also easily injured by fire, which spreads readily through the dead, dry, flammable lower limbs and frequently to the crown. Fortunately, the season of high fire risk is comparatively short at the elevations where Engelmann spruce grows.

Engelmann spruce cones are usually 1 to 2-1/2 inches long and have thin and somewhat papery, wedge-shaped scales, which are commonly notched at the apex (fig. 2). Seeds are about one-eighth of an inch long, nearly black, with wings about one-half of an inch long. Needles are 1 to 1-1/2 inches long, linear, four sided, blue green, and often blunt at the apex. The bark is very thin and is broken into large purplish-brown to russet-red, loosely attached scales (fig. 3).

The tree is a good-to-moderate seed producer, and seeds are viable over extended periods if properly stored. Germination is usually good when moisture is available. The early growth of spruce is slow at high elevations. Initial establishment and early growth are encouraged by shade and abundant moisture. Shade conserves moisture by reducing temperatures that cause water losses from both seedlings and soil. Shade also reduces light intensity, which at high elevations where spruce grows (especially in the central and southern Rocky Mountains), may be so great that it may injure or even kill new seedlings that start in the open. Engelmann spruce is more shade tolerant than any of its associates except the true firs, cedar, and hemlock, but does not exhibit the all-stage stand structure commonly associated with tolerant species. Engelmann spruce stands vary from single-story to multi-story stands.

Old-growth stands frequently have limited potential for management because of problems with potential windthrow and spruce bark beetle (*Dendroctonus engelmannii*). Often there is little choice but to harvest the area and start a new stand. Residual understory trees, where present, and some logging slash should be left to provide shelter for new reproduction. Where windfall and spruce bark beetles are not limiting, there is an opportunity to use a variety of cutting methods, depending upon management objectives.

Common Names

Engelmann spruce is the name most commonly used; it honors George Engelmann (1809–84), a botanist and authority on conifers. Other names are Columbian spruce, mountain spruce, silver spruce, and white spruce.

Related Commercial Species

Blue spruce (*Picea pungens* Engelm.) is included in the reported totals of sawtimber and wood of Engelmann spruce. This species is found in the Rocky Mountain region, mostly in the mountains of Colorado, Utah, Montana, Idaho, Arizona, and New Mexico.

Supply

In 1977, the total volume of Engelmann spruce of sawtimber size in the United States was estimated at about 68 billion board feet. About 50 percent of

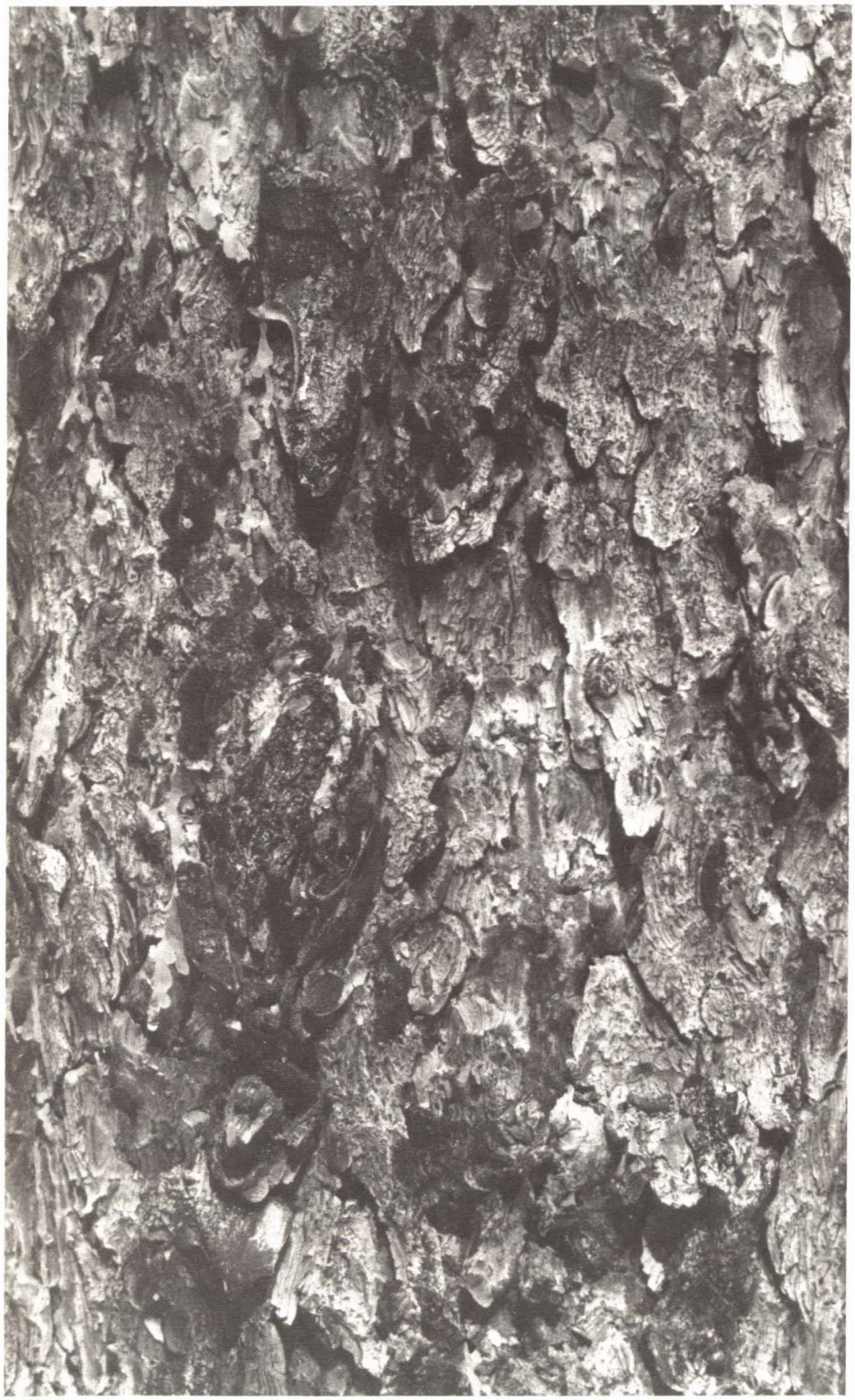

Figure 3—Bark of Engelmann spruce. F-438101

the total volume was in the southern Rocky Mountain region, about 41 percent in the northern Rocky Mountain region, and the remainder primarily in the Pacific Northwest. Over one-third of the estimated 68 billion board feet in 1977 was in Colorado. The following States contained lesser quantities in decreasing order: Idaho, Montana, Wyoming, Utah, Oregon, Washington, New Mexico, Arizona, Nevada, and California.

Production

The production of Engelmann spruce lumber has fluctuated widely, but had shown a generally increasing trend from 1869 to the mid-1950's (fig. 4). It rose spectacularly between 1949 and 1956, from approximately 86 million board feet to a record of 795 million board feet. This marked increase reflected major efforts to salvage insect-killed timber during and immediately following a major bark beetle epidemic. Since 1956, production has been somewhat below this peak, and again, it has varied considerably. In 1979, about 91 percent of the total lumber produced came from the northern and southern Rocky Mountain regions. For the period from 1970 to 1979, the average production of lumber was about 420 million board feet per year.

The spruce bark beetle is the most serious insect threat to production of Engelmann spruce in both mature and overmature stands, and epidemics have occurred throughout recorded history. One of the most damaging recorded outbreaks was in Colorado from 1939 to 1951 when beetles killed nearly 6 billion board feet of standing spruce. Damaging attacks have been largely associated with extensive windthrow, but may also occur under other conditions, for instance, when cull material is left after logging. Engelmann spruce is attacked by other insects, but only the defoliating western spruce budworm (*Choristoneura fumiferana*) has the potential to pose serious problems.

The most common diseases are caused by wood-rotting fungi that result in loss of volume and predispose trees

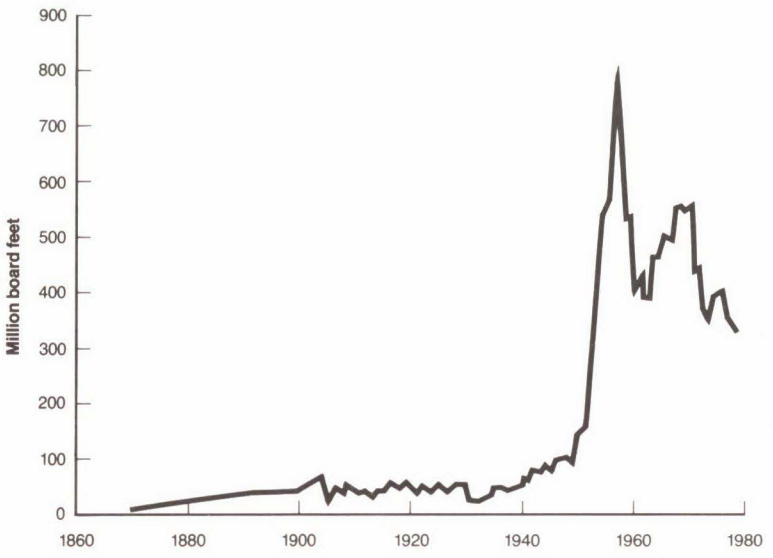

Figure 4—Lumber production of Engelmann spruce, 1869–1979.

to windthrow and windbreak. Spruce broom rust (*Peridermium coloradense*) is also common, causing bole deformation, loss of volume, spiketops, windbreak, and providing infection courts for decay fungi.

Characteristics and Properties

The heartwood of Engelmann spruce is nearly white, and has an occasional slight tinge of red. The narrow sapwood, generally 3/4 to 2 inches wide in trees of sawtimber size, is often difficult to distinguish from the heartwood but is commonly lighter in color. The annual growth rings are fairly distinct, showing a marked difference in color between the latewood and the earlywood of the succeeding year. The transition from earlywood to latewood is gradual. The wood has a medium to fine texture. It has no characteristic taste or odor. Engelmann spruce contains resin ducts, but they are relatively few and often visible only as white specks in the latewood.

The wood of Engelmann spruce is generally straight grained, has moderately low shrinkage, can be satisfactorily air-dried or kiln-dried, and is easily worked. It is one of the lightest important commercial woods of the United States, and has a specific gravity of 0.33 based on ovendry weight and green volume. The average weight of Engelmann spruce at 12 percent moisture content is approximately 24 pounds per cubic foot. Because the wood is lighter than many woods, it has lower strength, shock resistance, and nail withdrawal resistance than the heavier woods. However, because it is a lighter wood, it tends to split less easily than a heavier wood when nailed.

In paint-holding properties, Engelmann spruce is classed with ponderosa pine and western hemlock. It is not as suitable for paint-holding as white pines, cedars, redwood, and cypress, but it is better than Douglas-fir and southern yellow pine. Englemann spruce, Sitka spruce, and the eastern spruces glue easily under a wide range of gluing conditions. The heartwood and sapwood of Engelmann spruce are susceptible to decay; in this characteristic it ranks with the hemlocks. The wood of Engelmann spruce is considered difficult to penetrate with preservative, but properly incised crossties, pressure treated with creosote, have given satisfactory service.

Because Engelmann spruce is not a self-pruner, the lumber is quite likely to contain many small knots formed by numerous small limbs, which persist for a long time, even near the base of a tree where shade is heavy. Consequently, the species yields only minor amounts of select grades of lumber, but a relatively high proportion of lumber in the upper common and dimension grades.

Engelmann spruce has excellent pulpmaking and papermaking properties, ranking with the eastern spruces (white, red, and black) long used in the manufacture of paper pulp. It has long fibers, a relatively light color, an absence of resin, and is readily pulped by the sulfite, sulfate, and groundwood processes. Both sulfite and sulfate processes produce strong papers of fine texture.

Sulfite pulp produced from Engelmann spruce has an excellent color, bleaches easily, and is suitable for the manufacture of newsprint, and wrapping, book, high-grade printing, and bond papers. Sulfate pulp also has satisfactory bleaching properties similar to those of white spruce, and is suitable for high-grade kraft wrapping paper and fiberboard.

Engelmann spruce pulp is also easily produced by the groundwood process to yield a pulp of excellent color and standard strength suitable for uses such as newsprint, paperboard, and molded egg containers. The power required to operate the grinders when it is pulped by the groundwood process is about the same as required for white spruce.

Principal Uses

In the past, Englemann spruce was used primarily for mine timbers, railroad ties, and poles; minor amounts are still used for these purposes in the central Rocky Mountain area. Recently, it has been used principally for home con-

struction, especially in the form of interior framing, wall sheathing, roof sheathing, subflooring, shelving, wall paneling, exterior trim, and other general millwork items. Also in recent years, rotary-cut veneer from Engelmann spruce has been used for plywood manufacture in both the northern and southern Rocky Mountain areas.

Engelmann spruce is used in the manufacture of boxes and crates, furniture, trailer coaches, aircraft, motor vehicles, machinery, store fixtures, and mattresses. Sawmill and veneer mill residues comprise most of the pulping material used for the manufacture of pulp and paper.

Because of the high strength to weight ratio, some clear Engelmann spruce wood was used, along with Sitka spruce, to construct aircraft during both World Wars. The wood has also been used for the manufacture of violins and pianos because of its resonant qualities.

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